NTS GEOPROBE

STANDARD OPERATING PROCEDURES

GEOPROBE DESCRIPTION

NTS collects samples from various earth materials with a Geoprobe Systems® (geoprobe) Model 5400 mounted in a Ford F350 4x4 Pickup and 6610 DT Track Mounted direct push sampling technology. The sampling system is capable of collecting soil, soil gas, and groundwater samples at depths exceeding 100 feet.

The geoprobe consists of a percussion probe driven by a hydraulic pump powered by the carrier vehicle engine. The belt driven hydraulic pump supplies 10 gpm at 2000 rpm, 2250 psi operating pressure. Remote vehicle ignition allows the operator to start the vehicle engine from the rear geoprobe control panel. The probe unit folds for transportation and can be set up again in seconds. The geoprobe utilizes the static force (weight of vehicle) and hydraulic percussion to advance small diameter probing tools (1.0” O.D. to 1.6” O.D.) to depths that are limited only by soil type and depth to bedrock, usually over 30 feet. An eight horsepower hydraulic hammer issues over 1800 blows per minute. The hammer features a 0-300 rpm LH directional rotary function for drilling surface pavements. The unit has more than 12,000 lb. of pulling capability for tool removal.

PROBE DRIVE SYSTEM OPERATIONS

GENERAL PROBING:

1. Attach assembled sampler (see macro-core or large bore sampler below) onto leading Geoprobe probe rod. (A 12” probe rod is recommended to initially drive the Standard 24” and the Large Bore samplers. Replace the 12” rod with a 24” or 36” probe rod as soon as the sampler is driven below the surface.)
2. Drive the sampler into the ground. Stop when the drive head is just above the surface and re-tighten the stop-pin using a 3/8” wrench for the pin and a 1” adjustable wrench for the drive head. Most vibration that could loosen the stop-pin occurs with the initial driving. Failure to tighten the stop-pin could result in damage.

3. Drive the sampler to the top of the desired sampling interval. Attach additional probe rods as necessary to reach depth.

4. Some soil conditions may warrant using a large-bore pre-probe (AT-146B) or solid drive point to pre-probe the hole to the desired depth. Damage may occur as the sampler is driven into rock or other impenetrable layer.

**STOP-PIN REMOVAL**

1. With the extension function move the geoprobe hammer away from the top of the probe rods to allow room to work.

2. Remove the drive cap and lower extension rods down the inside diameter of the probe rods using couplers to join rods together.

3. Attach the extension rod handle to the top extension rod and rotate the handle clockwise. Some resistance is felt when the stop-pin disengages. Continue rotating the handle until the resistance ends. Check if the threads are completely disengaged by lifting up on the handle.

4. Remove the extension rods from the probe rods. The stop-pin is attached to the end extension rod upon removal.

**SAMPLE COLLECTION (Variable Depending On Sampling Tools)**

1. Replace drive cap onto the top probe rod. If the top of the probe rod is already in the lowest driving position, it is necessary to attach another probe rod before driving.

2. Mark the top probe rod with a marker or tape at the appropriate distance above ground surface.

3. Drive the sampler an additional 24”. Be careful not to over-drive the sampler, which could compact the soil sample, making it difficult to extrude.

**SOIL SAMPLING SYSTEMS**

The geoprobe system allows for soil sample collection either continuously or from discrete depth intervals. Two separate tool systems (Large-Bore and Macro-Core) are dedicated for soil sample collection.

**LARGE BORE (LB) SAMPLING SYSTEM**

The Large Bore Sampling System allows for collection of discrete two (2) foot soil samples at any desired depth intervals. The soil samples are retained in PETG plastic liners that may be sealed
with color-coded plastic end caps. Parts that encounter soils are minimized, greatly decreasing
time required for decontamination.

LARGE BORE (LB) SAMPLING EQUIPMENT:

- Geoprobe Model 5400
- 12” and 24” Probe Rods (AT-106B, AT-104B)
- Drive Cap (AT-11B)
- Pull Cap (AT-12B)
- Assembled LB Sampler (AT-660, At-661, AT-664)
- LB PETG Liners (AT-665K)
- LB Vinyl End Caps (AT-641K)
LARGE BORE (LB) SAMPLING OPERATION

1. Geoprobe patented Large-Bore Probe-Drive Samplers are tools for collection of 22” long x 1-1/16” diameter samples.
2. The samples are collected in PETG, brass, stainless steel or Teflon liners depending on analytical requirements.
3. The large-bore samplers provide a closed barrel system that allows driving to any discrete depth interval while remaining completely sealed.
4. Upon reaching the desired sampling depth, the piston stop-pin at the trailing edge of the sampler is removed.
5. As the sample barrel advances downward, the internal piston retracts allowing displacement by the soil sample.

EXTRUSION OF SOIL SAMPLES

1. Manual extrusion from the Large Bore Sampler is accomplished as follows:
2. Large Bore liners are removed from the sample tube by unscrewing the cutting shoe and pulling out the liner.
3. Occasionally it is necessary to remove the drive head and push the liner and sample from the barrel of the sampler.
4. Plastic liners are usually cut lengthwise with a utility knife to remove the sample.
5. Brass and stainless steel liners come with a plastic cladding on the outside of the liner to keep four six-inch sections aligned. Removal of the cladding on the outside of the liner allows cutting of the sections with a knife.

MACRO CORE (MC) SAMPLING SYSTEM

Macro-Core Samplers provide continuous sample collection downward from the ground surface using 45’ long x 1-1/2” diameter tool, which retains the sample in PETG (clear plastic) liner tubes. If deeper sampling is needed, the soil above the desired sampling interval must be removed. Lowering the sampler down the previously sampled hole and connecting additional probe rods until the sampler reaches the top of the new sampling interval allows collection of additional sample intervals. Continuous sampling depends on the hole staying open. After collection, the sample tubes are removed from the macro-core barrel, and the ends are sealed using color-coded plastic end caps to identify the top and bottom of the sample. Any additional notes (probe-hole number, date, sample interval, and location) can be written directly on the tubes to assist later logging of the soil characteristics or laboratory sample preparation.
MACRO CORE (MC) SAMPLING EQUIPMENT:

- Geoprobe Model 5400
- 12” and 24” Probe Rods (AT-106B, AT-104B)
- Drive Cap (AT-11B)
- Pull Cap (AT-12B)
- Assembled MC Sampler (AT-720, AT-722)
- MC PETG Liners (AT-725)
- MC Vinyl End Caps (AT-727)
- 45” Extension Rods
- Extension Rod Couplers

MACRO CORE (MC) SAMPLING OPERATIONS

1. Connect a drive cap to the drive head at the top end of the sampler.
2. Raise the probe shell to its highest position. Next, raise the foot off the ground surface to allow room for placement of the sampler below the hammer. Be sure to plumb the probe-hammer, sampler and rod assembly.
3. Insert an anvil into the hammer and place the sampler and probe rod in the driving position.
4. Raise the hammer latch into the up position while initially driving the sampler to avoid contact with the drive head.
5. Use the FOOT control to apply down pressure and activate the hammer as necessary to advance the sampling assembly. When the foot reaches the ground surface, begin using the probe control to apply down pressure as in normal operation.
6. Add a probe rod and drive the sampler (48”) until the drive head reaches the ground surface, being careful not to over-drive the sampler.
7. For sampling consecutive intervals, lower the sampler down the previously made hole by connecting probe rods together until the bottom end of the sampler stops at the next sampling interval.

MACRO CORE (MC) SAMPLE REMOVAL

1. If sampling below the four-foot surficial interval, pull out all of the probe rods until the sampler is exposed just above the ground surface.
2. When the sampler is visible above the ground surface, attach a pull cap to the top of the drive head.
3. Continue to pull the sampler out of the hole using the PROBE control.
4. When the limit of the 40” probe stroke is reached, continue to pull the sampler up using the FOOT control.
MACRO CORE (MC) SAMPLE RECOVERY

1. After the sampler has been removed from the hole, the soil sample is easily recovered by unscrewing the cutting shoe and pulling the liner out.

2. The exterior of the cutting shoe features a notch for attaching the Shoe Wrench (part # AT-727) to loosen tight threads.

3. Applying a sharp blow to the notch with a flat screwdriver and a hammer is also useful for loosening the cutting shoe.

GROUNDWATER SAMPLING SYSTEMS

The geoprobe system provides several alternative methods for sampling groundwater. Three systems are commonly utilized depending upon the sample requirements. Expendable drive point probes allow depth to groundwater measurement, or sample collection if the aquifer is composed of coarse enough material to prevent blow back of solid sediment into the probe rods. For finer grained aquifers, either a Screen Point Sampler or a Mill Slot Screen Sampler is utilized.

EXPENDABLE POINT GROUNDWATER SAMPLING EQUIPMENT:

♦ Geoprobe Model 5400
♦ 12” and 24” Probe Rods (AT-106B, AT-104B)
♦ Drive Cap (AT-11B)
♦ Pull Cap (AT-12B)
♦ Expendable Drive Point (AT-14)

EXPENDABLE POINT GROUNDWATER PROBING OPERATIONS

1. Place a drive cap on the assembled sampler and drive it into the subsurface.

2. Continue driving by adding probe rods until the sampler tip has been driven about one foot below the target sampling depth.

3. After reaching the groundwater depth, disengage the expendable drive point by pulling the rods back a distance of about 2 feet.

4. Lower the sensor of an electric water level indicator until the audio signal sounds and record the depth to groundwater. The measurement tape scale (0.01 ft intervals) on the water level indicator wire is read at the top of the probe rod after pulling the tape out and extending it to the ground surface.

5. After the recording the water level depth measurement, the indicator sensor is removed from the geoprobe rods.

6. If required, tubing or smaller diameter bailer is inserted into the probe rods to collect a water sample.
SCREEN POINT SAMPLER EQUIPMENT:
- Assembled Screen Point (GW-440K)
- Geoprobe Model 5400
- 12” and 24” Probe Rods (AT-106B, AT-104B)
- Drive Cap (AT-11B)
- Pull Cap (AT-12B)
- 3/8” O.D. x 1/4” I.D. Polyethylene Post-Run Tubing (PRT)
- GW Expendable Drive Point (GW-445)
- Bottom Check Valve (GW-42)

SCREEN POINT SAMPLER OPERATIONS

Stable Formations:
1. The screen assembly may be pushed out into the open borehole by lowering 3/8” tubing affixed with a PRT adapter (TB-25L, PR-25S) to the top end of the screen assembly.
2. The threads on the PRT adapter are engaged with the threads on the screen connector by pushing gently downward on the tubing and rotating it counter-clockwise.
3. When properly connected, pushing down on the tubing can push the screen assembly out of the sampler sheath exposing the screen to the saturated zone.
4. The water sample is collected through the tubing.

Unstable Formations:
1. The screen assembly may have to be pushed out of the sampler sheath by means of extension rods inserted down the inside of the probe rods.
2. The end of the rods should be equipped with an extension rod coupler (AT-68) to protect the threads of the screen connector.
3. A steady push is sufficient, avoid excessive hammering on the rods.
4. After pushing the screen into the saturated formation, remove the extension rods and begin sample collection.

GROUNDWATER SAMPLING
1. Groundwater sample collection may be accomplished by using 3/8” tubing and a stainless steel PRT adapter as previously described.
2. Once the PRT adapter and screen connector are connected, a vacuum may be applied to the top of the tubing for sample collection utilizing a peristaltic or vacuum pump, with an in-line trap.
3. Another water sampling option is tubing with a bottom check valve (AT-42).
4. Oscillating the tubing up and down causes repeated lifting and seating of the ball check valve, which moves the water column upward into the tubing.
5. The tubing will begin to feel heavier as it fills with several feet of water.

6. The tubing can then be lifted out of the probe rods, cut, and the water poured into a vial for transport to either an on-site or fixed laboratory for analysis.

7. Collection of multi-liter samples are possible using the tubing/check valve assembly technique.

GROUNDWATER SAMPLE REMOVAL

1. The groundwater sampling assembly is extracted from the probe rods after the sampling procedure is finished.

2. If the PRT system is used, remove the tubing by pulling up firmly on it until it disconnects from the PRT adapter down-hole.

3. The PRT adapter will remain attached to the screen connector.

4. After recovery of the sampler, examine all parts for wear, damage, or contamination.

5. Clean all parts thoroughly, replace the O-rings, and prepare for the next sample.

MILL SLOTTED WELL POINT EQUIPMENT:

♦ Assambled Mill Slot Sampler (GW-40)
♦ Geoprobe Model 5400
♦ 12” and 24” Probe Rods (AT-106B, AT-104B)
♦ Drive Cap (AT-11B)
♦ Pull Cap (AT-12B)
♦ 3/8” x 1/4” I.D. Polyethylene Tubing
♦ GW Expendable Drive Point (GW-445)
♦ Bottom Check Valve (GW-42)

MILL SLOTTED WELL POINT SAMPLING OPERATIONS

1. The mill-slotted well point sampler threads directly onto the leading probe rod. The mill-slotted well point is 36” long x 1.0” O.D. with a slotted section 24” long x 0.76 I.D. Each mill-cut slot is 2.0” long x .020” wide.

2. This open slotted tool is driven or lowered from the ground surface into the saturated zone.

3. Inserting an inner tubing or smaller diameter bailer down the inside diameter of the probe rods allows collection of a water sample.

4. Connecting the 24” long slotted section (GW-44) together with mill-slotted rod coupler (GW-45) increases the surface area exposed to the slots.

5. This tool works best in sandy aquifers and is not recommended for use in silty, clay-rich soils.

6. Driving a larger diameter pre-probe (AT-146B) ahead of the slotted section is often used with this tool to minimize clogging of the mill slots.
HARD SURFACE OPERATIONS

ASPHALT AND/OR SEMI-HARD SURFACE OPERATIONS

Asphalt surfaces less than 6 inches thick, or other semi hard surfaces such as gravel roads are easily penetrated using a large bore or macro-core pre-probe.

PRE-PROBE EQUIPMENT

- Geoprobe Model 5400
- 12” and 24” Probe Rods (AT-106B, AT-104B)
- Drive Cap (AT-11B)
- Pull Cap (AT-12B)
- Large Bore (AT-150B) or Macro Core (AT-147B) Pre-Probe.

PRE-PROBE OPERATION

1. Attach a 12” probe rod to the desired pre-probe with a drive cap and center the assembly beneath the probe hammer.
2. Drive the assembly like any other sampling tool, paying particular attention to the alignment with the hammer.
3. NOTE: Hearing and eye protection are especially important during pre-probing!
4. After the hard surface or obstruction is penetrated remove the assembly with the pull cap and proceed as usual.
MONITORING WELL INSTALLATIONS

Monitoring wells are required at many investigation sites. The geoprobe direct push system is capable of installing small-diameter (3/4 – 1 inch) monitoring wells. As with other geoprobe operations, the monitoring well installation by direct push methods does not produce drill cuttings. While GEOPROBE manufactures Prepacked Screen Monitoring Wells, NTS has found that installation of standard small-diameter PVC screens can provide more options for varying screen lengths. The larger inside diameter of standard PVC screens also allows more options for water level measurement and/or sampling tools. Standard PVC well screens and threaded riser pipe is also less expensive than the GEOPROBE Prepacked Screen Monitoring Wells. NTS will install either standard PVC or GEOPROBE Prepacked Screen Monitoring Wells as required by clients.

MONITORING WELL EQUIPMENT

♦ GEOPROBE Model 5400
♦ GEOPROBE GS1000 Series Grout Pump
♦ 3/8-in. polyethylene tubing for pressure grouting
♦ 2.125-in.O.D. X 1.5-in. I.D. Probe Rods (AT-2148)
♦ O-rings for probe rods (AT2100R)
♦ Expendable Anchor Points or Expendable Drive Points (GW2040/AT2015)
♦ Drive Cap (AT-2101)
♦ Pull Cap (AT-2104)
♦ 60-100 Mesh Glass Beads or 20/40 Environmental Silica Sand or (AT93/AT95 or other non-GEOPROBE supplier) for screen filter pack
♦ Bentonite for well seal and grouting well annulus (manufacturers vary)
♦ Schedule 80 PVC Well Screen and Riser Pipe (manufacturers vary)

SMALL DIAMETER MONITORING WELL INSTALLATIONS

1. Place a drive cap on the first section of 2.125-in. probe rod with an expendable drive point installed and begin advancing the rod into the ground.
2. Continue driving by adding probe rods, with O-ring seals between each rod, until the sampler tip reaches approximately one foot below the screen installation depth.
3. After reaching the installation depth, the PVC well screen is lowered into the probe rods while adding threaded lengths of PVC riser pipe as needed. Care must be taken to tighten the threaded sections to prevent leakage at the joints. New, clean, rubber gloves are worn while handling all well screen and riser pipe materials to provide the highest quality samples from the well after installation.
4. After the screen and riser are set at the installation depth, the probe rods are retracted slightly while holding down pressure on the riser pipe. This disengages the expendable point from the bottom section of drive rod.

5. After disengaging the drive point, the screen is exposed to the aquifer. Before proceeding with the well installation, it is prudent to measure the static water level in the well. This allows for adjustment of the proper screen depth if required.

6. After assuring the proper installation depth, filter-pack sand (60-100 Mesh Glass Beads or 20/40 Environmental Silica Sand) is placed within the annular space between the well screen and probe rods. The sand is poured slowly to prevent bridging. The spherical shape of the 60-100 Mesh Glass Beads minimizes the potential for bridging.

7. Filter sand is added, while retracting the probe rods, until the sand reaches approximately two feet above the screen length.

8. If the native formation is well-sorted sand, coarse enough to filter and not pass through the well screen filter sand may be unnecessary. Retracting the probe rods to approximately two feet above the top of the screen will allow collapse of the native formation around the screen.

9. Above the filter pack, a minimum two-foot thick bentonite seal is installed to prevent any infiltration from above reaching the sand pack and/or well screen. The bentonite seal is tremied from the bottom (top of the filter pack), with the GEOPROBE high-pressure grout pump while retracting the probe rods.

10. A bentonite slurry can be used to grout the entire well annulus, or alternatively above the required minimum two-foot thick bentonite seal, the annulus can be grouted with neat cement.

11. Following two days, as required by the Minnesota Department of Health (MDH), development and sampling of the well can proceed as for typical larger diameter wells.

SOIL-GAS INVESTIGATIONS

The Geoprobe System has a long history of use on soil-gas sampling projects. In fact, soil gas sampling was the first application of the system before any specific soil and groundwater sample collection tools were designed for the geoprobe. Soil-gas surveys can provide useful data regarding areal extents of subsurface contamination or other analytes of interest.

Three active soil-gas sampling options are available depending on clients needs. The options include:

1. Direct sampling through the probe rods using an expendable drive point.
2. Sampling through the probe rods using a retractable sampling point.
3. Sampling through post run tubing (PRT) inserted into the probe rods.
4. Permanent soil-gas implants.
The first two options can be used for less demanding investigations, since collection of the soil-gas directly through the probe rods requires sealing the probe rod joints (Teflon® tape) and thorough decontamination of the probe rods. NTS recommends the PRT soil-gas sampling technique since it eliminates the potential problems with the other options. The PRT soil-gas sampling also:

- Increases the speed and accuracy of the soil-gas sampling.
- Eliminates probe rod leakage and sample carryover problems.
- Utilizes a simple design for easy use and verifiable vacuum-tight sample collection.
- Since the PRT methods are used after driving the probe rods to the target depth, standard probing techniques are used prior to sample collection.

COMPONENTS FOR PRT SOIL-GAS SAMPLING

- Tubing, either polyethylene, Teflon®, or stainless steel
- Probe rods, lengths and number of sections as required to reach target depth
- PRT adapter
- Expendable point holder
- Expendable points
- Silicone tubing with adapters to connect the down-hole tubing to the vacuum pump suction tubing
- O-rings for PRT adapter and expendable point holder
- GEOPROBE Vacuum/Volume System (installed in probe truck)

PRT SOIL-GAS SAMPLING OPERATIONS

1. Clean/decontaminate all sampling components prior to use, and check inside diameter of probe rods for obstructions.
2. Test fit treads of PRT adapter and PRT expendable point holder for smooth coupling. **NOTE:** PRT fittings are left-hand threaded.
3. Push adapter into the end of the selected tubing. Securing the tubing to the adapter with tape will not influence sample integrity.
4. After assembling the PRT expendable point holder to the expendable drive point insert into the end of the first probe rod and proceed driving and adding rod sections until reaching the target depth.
5. After reaching the target sampling depth, disengage the expendable drive point by pulling up on the probe rods.
6. Remove the pull cap and retract the probe hammer assembly away from the rods for additional working room.
7. Insert the adapter fitted end of the sample tubing into the probe rods. Continue feeding the tubing into the rods until reaching the bottom (expendable point holder).
8. Allow at least two feet of excess to extend beyond the top of the probe rods before cutting the tubing.
9. Apply downward pressure on the tubing while turning it (counterclockwise) to engage the threads of the expendable point holder. Pull up tightly on the tubing to test the thread engagement.

10. Connect the upper end of the down-hole tubing to the silicone tubing to the vacuum-system suction line with the appropriate adapters.

11. Follow appropriate purging and sampling procedures for the planned analytical method for the investigation.

12. Following sample collection, disconnect the tubing from the vacuum system and pull the down-hole tubing up firmly until it releases from the adapter at the bottom of the hole.

13. Remove all the tubing from the probe rods and dispose polyethylene tubing and/or decontaminate Teflon® tubing following the investigation protocol.

14. Retrieve the probe rods and recover the expendable point holder with the attached PRT adapter.

15. Inspect the O-rings on the expendable point holder/PRT adapter assemblies, and move to the next probe location.

PERMANENT SOIL-GAS IMPLANTS

Installation of permanent soil-gas implants with the Geoprobe System and are also performed using “post-run” methods. Essentially, installation of permanent soil-gas implants is a hybrid between the methods used for installing small-diameter monitoring wells and PRT soil-gas sampling. The only significant difference is the stainless steel vapor sampling implants, which are available in varying sizes and lengths.

Implants are installed post-run and connected to the implant anchor connected to the bottom probe rod after reaching the target depth as described for PRT soil-gas sampling. After the implant and tubing are connected to the anchor, the tubing becomes the “riser pipe” for the permanent installation. A filter pack of silica beads is placed around the implant and the annulus between the tubing and the probe rods is grouted using the same methods as described for monitoring well installations.
ROTARY DRILLING FOR CONCRETE AND/OR FROST

The Model 5400 Geoprobe includes a rotary drilling function that simultaneously operates when needed with the hammer. Carbide tipped drill steels are available in 18, 24, 30 and 36 inch lengths.

CONCRETE ROTARY DRILLING EQUIPMENT

♦ Geoprobe Model 5400
♦ Drill Steel (AT-31 through 42 depending on length)
♦ Carbide Tipped Bit (AT-36 through 44 depending on diameter)
♦ Hex Drive Adapter (AT-46)

ROTARY DRILLING OPERATION

1. Remove the anvil from the geoprobe hammer by pulling down on the retainer cap.
2. Install the drill steel in the hammer with the appropriate retainer cap.
3. Lower the probe until the drill steel contacts the concrete surface and lifts the foot approximately 2 inches. Do not lift the foot of the probe more than 3 inches above the ground surface since the drill assembly could bend during drilling.
4. Balance hydraulic power between the hammer function and the rotary function with the ROTARY LEVER located near the top of the hammer.
5. Begin drilling by pressing down on the HAMMER LEVER.
6. As the carbide tip begins to penetrate the surface, flush the hole liberally with water to cool the bit.
7. Minimizing the hammer function while drilling produces a clean hole and avoids seizing the bit. Also raising and lowering the drill steel frequently helps clear cuttings from the hole.
8. After the concrete is penetrated, proceed as usual.

FROST AUGERING EQUIPMENT

♦ Carbide-Tipped Frost Bit, 2.5 in. (AT5005)
♦ Frost Auger Section Assembly, 4 ft. (AT5010)
♦ Frost Auger Connecting Pins (AT5011)
♦ Hex Drive Adapter (AT5015)
♦ Anvil Retainer Cap Assembly (AT4200)
FROST DRILLING OPERATION

1. Remove the anvil from the geoprobe hammer by pulling down on the retainer cap.
2. Install the frost auger section assembly in the hammer with the appropriate retainer cap.
3. Lower the probe until the frost auger bit contacts the concrete surface and lifts the foot approximately 2 inches. Do not lift the foot of the probe more than 3 inches above the ground surface since the drill assembly could bend during drilling.
4. Balance hydraulic power between the hammer function and the rotary function with the ROTARY LEVER located near the top of the hammer.
5. Minimize use of the percussion hammer of the rig, since the frost bit is specifically designed for rotary drilling only.
6. Raising and lowering the frost auger assembly helps clear cuttings from the hole.
7. After the frost is penetrated, the auger advances easily.
8. Change back to the appropriate geoprobe tooling and proceed as usual.